Meeting Summary: Jan. 26, 2011 N_2O Stakeholder's Meeting

Additional information is provided in the researchers' presentations, which are attached to the email message containing this summary.

Research Updates

CEC Contracts: Johan Six, Martin Burger (UC Davis)

N2O Fluxes in Vineyards and Tomatoes

Vineyards

- The study design primarily evaluates cumulative N2O fluxes (kg N2O-N/ha/day) both seasonally (summer, winter) and spatially (vine row vs. tractor row); CH4 and CO2 are also evaluated. In addition, other parameters are measured to help explain differences in N2O fluxes, including temperature, nitrate, nitrite, mineral N, moisture content, and dissolved organic carbon.
- The Arbuckle site is an established vineyard. The vine row is surface drip irrigated (SDI) every 2-3 days (16 cm H2O/ha/yr or "spoon fed") and 5 kg N/ha is applied once per year via fertigation. The tractor row was not irrigated or fertilized, but is disked to 6 cm twice per growing season. The leguminous winter cover crop is disked in during Tillage Event 1 in late March; associated N inputs were not evaluated.
- Vine Row measurements: During the growing season, fertilization events had the largest influence on emissions, with fluxes of about 12 g N2O-N/ha/day. In the winter, precipitation events had the largest fluxes, with the maximum flux (~25 g N2O-N/ha/day) occurring after the first rainfall of the season. Subsequent rainfall events had fluxes of less than 5 g N2O-N/ha/day. NO3 and the water filled pore space (WFPS) also had peak fluxes after the first rainfall.
- Tractor Row measurements: N2O fluxes did not increase following the two tilling events. The first precipitation event had the largest observed flux, 400 g N2O-N/ha/day, primarily due to accumulation of vegetation over the summer; NO3 and WFPS had peak fluxes as well. Far smaller fluxes (<50 g N2O/ha/day) were associated with subsequent precipitation events.
- Cumulative N2O fluxes (kg N2O-N/ha/yr):
  Vine Row, summer = 0.13 Vine Row, winter = 0.28
  Tractor Row, summer = 0.07 Tractor Row, winter = 4.08
  Adjusted cumulative flux for vineyard = 3.0

Tomato System

- Two systems with the same cultivar were evaluated:
  Conventional System (CONV) - conventional tillage, furrow irrigation, fertilizer shanked into bed sides, rip/reform beds), and
  Integrated System (INT) - reduced tilling, sub-surface drip irrigation (SSDI) and fertigation, winter grain cover crop, preserve planting beds).
- N Fertilizer inputs: CONV = 209 kg/ha; INT = 190 kg/ha. There was no zero N plot.
- Yield: CONV = 35 tons/ac; INT = 53 tons/ac
- Fluxes at three functional locations were compared: berm (mid-bed), sides, and furrow.
- Cumulative N2O emissions were 2.5-fold lower in the INT system, which received less fertilizer in smaller, more frequent fertilizer events compared to the CONV system. For both systems, fertilizer events produced the largest sustained fluxes.
- The INT system showed reduced N2O emissions and soil mineral N in the growing season, reduced excess NO3 and NH4 in the soil, increased N use efficiency, and had a positive effect on yield, compared to the CONV system.

GHG Emissions as Affected by Biochar Soil Amendments

A three year research project will begin in 2011 at a walnut farming/drying/packing operation. Walnut shells, pyrolyzed at 900 ºF, generate electricity to power the coolers and produce 1% by weight of carbon stock as biochar. The biochar contains 45% by weight as carbon, has a high cation exchange capacity and surface area, significant potassium salts and a pH around 10. Plots of biochar additions were installed in two grower fields (vineyard and walnut) and one market garden of the university. The study will evaluate the interactions between biochar, soil, soil microbes, crop and GHG fluxes; effects on pesticide activity will not be evaluated.

CDFA Contract, Dave Goorahoo (CSU Fresno)

N2O Fluxes in Silage Corn and Cotton

The study will evaluate the effects of N fertilizer (4 rates) on annual N2O fluxes in silage corn and cotton (Pima and Acala). Results will be used to calibrate and validate the DNDC model for California crops and conditions. Results from Fresno campus plots (15 x 15 ft; silage corn and Pima cotton) will be compared to results from field plots at grower sites (silage corn and Acala cotton). Sampling will be conducted March 2011 – April 2012 and will include ancillary soil and plant measurements (soil moisture profile, bulk density, temperature, biomass, N tissue analysis, etc.).

ARB Contracts, Will Horwath and Martin Burger (UC Davis)

N2O Fluxes in Lettuce, Tomatoes, Wheat and Alfalfa

The study examines N2O fluxes for different fertilizer rates over a full year. Result so far show N2O fluxes increase with increasing N application rates. The data will also be used to evaluate BMP's and to calibrate and validate the DNDC model for California crops and conditions.

- **Lettuce.** The research took place at both the UC Davis Agricultural Experiment Station in Salinas and on-farm. 30% of the monitored fields used SSDI and 70% used sprinklers. Five N fertilizer rates were evaluated (11 – 340 kg N/ha). The study took place over one growing cycle (July 2009 – Oct. 2009), with year-round monitoring through June 2010. N2O emissions increased linearly with increased fertilizer inputs. The first rainfall event was associated with a much larger flux than the second rainfall event. An overall emission factor of 0.1-0.2% was observed during the growing season at the Experiment Station, which is within the range of the literature and IPCC defaults. High organic soil N was observed following crop incorporation.
- **Tomatoes.** Monitoring was conducted from October 2009 to August 2010 in furrow and SSDI irrigated systems. Three fertilizer rates were evaluated; the highest emissions were observed after the highest N treatments (300 kg/ha). The single highest flux was observed following the first rainfall of the season (2 inches of rain). Because N2O is produced in the top 10 cm of the soil and SSDI systems are buried below 10 cm, lower emissions were observed for SSDI systems compared to furrow irrigated systems. The overall cumulative flux, corrected for background via subtracting emissions from a zero N plot, was 0.4 kg N2O-N/ha/yr. The overall emission factor was 0.2 – 0.3%.
- **Wheat.** From Nov. 2009 – June 2010, a cumulative flux of 0.97 N2O-N/ha/day was observed for a wheat system which received 204 kg N/ha while the flux in a zero N wheat system was 0.13 N2O-N/ha. The overall emission factor was 0.4%.

- **Alfalfa**. A first year and a fourth year stand were evaluated from March 2010 -Aug. 2010. Initially no significant difference in N2O flux was observed between the two sites. When the researchers increased the number of flux sampling chambers, they observed higher emissions for the first year stand (8.5 $\pm$ 2.7 g N2O-N/ha) compared to the 4th year stand (2.7 $\pm$ 0.8 g N2O-N/ha).

Assessment of Baseline N2O in Dairy Systems. Beginning in the spring of 2011, this one-year study will develop N2O emission estimates and emission factors by evaluating 5 events in silage corn receiving dairy lagoon water, corral manure and inorganic nitrogen as fertilizer. It will be conducted at two Stanislaus county sites and one Sacramento county site and will evaluate zero N inputs, reduced tilling and conventional tilling as variables. Water inputs are a challenge to measure; the research will involve placing sensors in the irrigation pipes.

NOx "Add On" Study to Improve Ozone Modeling In an effort to improve the predictive capability of ozone modeling, this study evaluates NOx flux concurrently with N2O flux in the ongoing study. Measurements are being collected in tomatoes, spring and summer wheat, corn, and almonds; contacts are underway to add one additional crop.

CalRecycle Contract, Will Horwath, (UC Davis)
This study will evaluate N_2O and CH_4 emissions from the compost life cycle, including emissions from finished compost additions to almonds, tomatoes and row crops. Monitoring in tomatoes has been underway since May 2010 at UC Davis' Russell Ranch. The researchers are working on locating another monitoring site. Work on the eddy current technique is ongoing at the compost facility. Recent research suggests that the traditional emission measurement methodology using flux chambers may underestimate compost emissions by 80% or more. Results will be evaluated by the three methods currently in use for measuring flux from compost. The lab phase has begun and results should be available at the next stakeholder meeting.

Stakeholder Discussion Items
Background N in annual crops. It seems appropriate for emissions estimates to subtract the background N contributed from the previous year. However, it is not always feasible to monitor a zero N field, the IPCC studies did not subtract for N and most literature studies do not report background N. The researchers will measure background N when feasible. However, the larger focus should be on assessing overall emissions.
Observed emission factors vs. IPCC emission factors. Thus far, the observed emission factors are in the range of 0.3 – 1 %. Perennial crops are anticipated to fall within the same range. ARB's inventory currently uses the IPCC emission factor of 1%.
Monitoring non-GHGs at compost facilities. This may not be a large concern in the near future, as facilities increasingly move to cap open windrows.
Round robin testing of QC samples. While all studies include testing of field and lab standards, should PI's assess inter-lab analytical consistency? We deferred discussion for the next meeting because two of the PI's had signed off. However, Will Horwath reported that his samples have sometimes been run on Dr. Six's GC which provides one cross-check. Also, Dave Goorahoo will send his samples to UC Davis for analysis, so at most two labs are involved.

Next Steps: The next N_2O Stakeholders meeting is tentatively planned for June, 2011.